EXHIBIT F

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APPROVED

PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(b)(2).

Docket Number	AWM-022.60	Type a plus sign (+) inside this box →	+

INVENTOR(S)/APPLICANT(S)

LAST NAME	FIRST NAME	MIDDLE INITIAL	RESIDENCE (CITY AND EITHER STATE OR FOREIGN COUNTRY)
Gross Greszczuk Padir	Rick John Halil		Acton, Massachusetts Stowe, Massachusetts North Andover, Massachusetts

TITLE OF THE INVENTION (280 characters max)

A MULTICARRIER TRANSMISSION SYSTEM WITH A LOW POWER SLEEP MODE AND WITH INSTANT-ON CAPABILITY

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ENCLOSED APPLICATION PARTS *(check all that apply)*

X	Specification	*Number of Pages*	4		Small Entity Statement	
X	Drawing(s)	*Number of Sheets*	0	X	Other *(specify)*	Certificate of Mailing

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT *(check one)*

	A check for $ is enclosed to cover the filing fee		FILING FEE AMOUNT ($) $150.00
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The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

X No.

☐ Yes, the name of the U.S. Government agency and the Government contract number are: _____

Respectfully submitted,

SIGNATURE Charles H. Cella Date 1/26/98

TYPED or PRINTED NAME Charles H. Cella REGISTRATION NO. *(if appropriate)* 38,099

☐ Additional inventors are being named on separately numbered sheets attached hereto.

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

Burden Hour Statement: This form is estimated to take 2 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO**: Box Provisional Patent Application, Assistant Commissioner for Patents, Washington, DC. 20231.

Aware Company Confidential Information

Title:

A multicarrier transmission system with a low power sleep mode and with instant-on capability.

Authors:
John Greszczuk, Rick Gross, Halil Padir

Date:
26 January 1998

Cross-reference to related applications

This application is based in part on the following patent applications:

U.S. Patent No. 5,497,398 dated March 5, 1996, authors Michael A. Tzannes and Marcos C. Tzannes;

U.S. Patent Application entitled Adaptive Allocation for Variable Bandwidth Multicarrier Communication filed June 12, 1997, inventors: George Kechriotis, Marcos Tzannes and Pui Wu, Serial number 08/873,421;

US Provisional Patent Application entitled Adaptive Allocation for Variable Bandwidth Multicarrier Communication filed June 12, 1996, inventors: George Kechriotis, Pui Wu and Marcos Tzannes, U.S provisional application Serial number 60/019,637;

and U.S. Provisional Application entitled: Splitterless Multicarrier Modulation for high speed data transport over telephone wires, filed October 10, 1997, inventors: Richard Gross, John Greszczuk, Dave Krinsky, Marcos Tzannes and Michael Tzannes, Serial number 60/061,689

and U.S.Provisional Application entitled: Dual Rate Multicarrier Transmission System in a Splitterless Configuration, filed January 16 1998, inventors: Richard Gross and Michael Tzannes.

and U.S.Provisional Application entitled: Dual Rate Multicarrier Transmission System in a Splitterless Configuration, filed January 21 1998, inventors: Richard Gross, Marcos Tzannes and Michael Tzannes.

Other references:
Patent #5428790 : Computer power management system
INVENTORS:Harper; Leroy D., Sunnyvale, CA et al.
ASSIGNEES:Fujitsu Personal Systems, Inc., Santa Clara, CAISSUED:June 27, 1995 FILED: Oct. 8 , 1993

Background

Computers for personal use have a feature whereby they can minimize their power consumption when not actively being used - a sleep mode. They can awaken from the sleep mode quickly, and resume operation when the user returns to the computer.
For a multicarrier modem, such as described in the above cross referenced patent applications , to be integrated with such a computer it also needs to have such a sleep mode, during which it has reduced power consumption. It also must awaken quickly to begin transmitting and receiving data.

A large part of the power consumed by a multicarrier modem is by the transmit line driver circuit and by the the digital circuitry that modulates and demodulates user data. In order to minimize the power consumption of the modem it is necessary for the transmitter to be able to shut down and for most of the digital circuitry to either shut down or operate at a reduced frequency and power consumption. The current state of the art multicarrier modems are unpredictable when resuming from a shutdown of the normal

transmit signal and a full initialization and training sequence must be executed which requies several seconds.

In central offices power consumption is also an issue, and a modem in the CO can reduce its power consumption when operating with a modem that is in a sleep mode, as it only has to generate a pilot tone, monitor the line for a signal to resume, and generate idle data for equipment connected to it.

Objects of the invention

It is an object of the invention to provide a multicarrier modem at the customer premises can maintain synchronization with the modem at the central office while in a low power sleep mode.

It is an object of the invention to provide a multicarrier modem that on awakening from sleep mode, can resume transmission and reception of data in a very short time , without requiring the normal multicarrier initialization sequence.

It is an object of the invention to provide a multicarrier modem that after a period of time with no received signal present , can resume transmission and reception of data in a very short time , without requiring the normal multicarrier initialization sequence.

It is an object of the invention that a multicarrier modem situated in a central office can operate at reduced power while the remote modem is in sleep mode.

Description of the invention

Terms:

The modem at the customer premises is the CPE.

The modem at the other end , which could be a phone company's central office for instance is referred to as the CO modem.

The pilot tone is an unmodulated carrier, generated by the CO modem at a frequency related to the frame rate.

Demodulation state refer to the values of adaptive parameters that are learned in the initialization sequence and may be monitored during normal operation. These include but are not limited to equalizer coefficients, echo cancellor coefficients, front end gain settings, phase locked loop phase offset and frequency offset values, depending on a particular implementation of a multicarrier receiver.

Operating state:

The modems will have performed the initialization sequence and have trained any equalizer or echo cancellors for the particular channel that they are on. The CPE modem will be using a frame clock it recovers from the received line signal., known as loop timing. The CO modem sends a pilot tone by leaving one the carriers unmodulated.

Entering sleep state:

This would be initiated by a signal from the main processor that the computer is idle. The CPE modem would signal the CO modem that it is going to enter a sleep mode. In the preferred embodiment this is done by passing a message in the embedded operation channel of the communications link. It also could be done stopping the transmission of user data and transmitting some signaling tones to the CO modem. When the CO modem acknowledges the sleep mode, the CPE modem will power down its transmitter.

Operation during sleep mode:

The CO modem will continue to transmit the pilot tone. This enables the CPE modem to maintain synchronization during the sleep mode. The CPE modem will maintain power to the receiver analog circuitry and a significantly reduced level of power to the digital circuitry, especially the digital

signal processing circuitry that consumes a large part of the power in normal operating mode. A digital phased locked loop (PLL) needs to be maintained to process the pilot tone and maintain synchronization with the CO. This involves adjusting its clock phase to maintain phase and frequency lock with the frame clock of the CO, and also to maintain a count of the number of frames and superframes elapsed.

The CO modem will have to maintain its previous demodulation state, and maintain a count of the number of frames and superframes elapsed. It will also have to monitor the line for the appearance of the 'awaken signal' from the remote modem. In the CO modem a large part of the digital signal processing circuitry can operate in a low power mode. It needs to keep power to its transmit line driver, and its other analog circuitry, but since only a pilot tone needs to be generated the modulation circuitry can be powered down. In a central office, the rest of the equipment is still operating, and while the link between the CO modem and the CPE modem is in a sleep state, user data provided by the CO modem will be benign idle data such as ATM Idle Cells or HDLC FLAG octets, and not generate false data errors to other equipment.

Awakening from sleep mode (Initiated by the CPE):

When initiated by the computer waking up, the CPE modem wakes up first and transmits a tone to the CO modem, signaling that it is about to leave sleep mode. Normally communications could resume immediately after a few frames. However if changes to the channel occurred while the modems where in sleep mode, a short reference signal for a few of frames could be used to verify that the communications are satisfactory before switching back to user data. If the training signal showed errors then a fall back to a longer retrain could be initiated by either modem. A change in the channel that could result in errors would be a different number of phones off-hook in a splitterless residential application.

Awakening from sleep mode (Initiated by the CO):

The CO modem will initiate the awakening by transmitting another tone – the awaken tone - agreed upon with the CPE in advance. The CPE modem will also maintain power to a small amount of circuitry that monitors the received line signal for this awaken tone.

Preliminary Claims:

A multicarrier modulation system that consists of :

1. A modem that is able to significantly reduce its power consumption, while it remains synchronized with the remote modem, and that after full power is resumed , can begin transmitting and receiving data 'instantly ', -within a few frames .

2. A modem as above, that also sends a short known reference signal to verify that the demodulation process has sufficiently small error for reliable transmission.

3. A modem as above that can perform a retrain sequence to re-adapt to new channel characteristics if the existing demodulator state is producing large errors.

4. A modem that can detect a signal from the other modem, and is able to maintain it's current state, when the other modem stops transmitting for a time and then resumes transmission so that upon resumption of transmission it can 'instantly' , within a few frames, transmit and receive user data.

5. A modem as in claim 4 , that sends the appropriate idle data to connected DTE equipment so that an error condition is not created when the mulicarrier system is in a sleep mode.

6. A modem as in claim 5. that also sends a short known reference signal to verify that the demodulation process has sufficiently small error for reliable transmission.

7. A modem as in claim 5 that can perform a retrain sequence to re-adapt to new channel characteristics if the existing demodulator state is producing large errors.

8. A modem as in claim 1 that while in a low power state can detect by processing the received line signal that the remote modem is signaling it to awaken and resume normal operation.

9. A modem as in claim 5, that can also signal to the other modem that it should to awaken and resume normal operation by transmitting a predefined signal.

10. A modem as in claim 5 , that operates with moderately reduced power consumption when transmitting only the pilot tone, monitoring the line for a signal to resume, and generating idle data for equipment connected to it.